# Product Data

## Torsional Vibration Meter — Type 2523

USES:

- General torsional vibration measurements and analysis on rotating components: engines, motors, prime movers, pumps, compressors, couplings, shafts, and dampers; marine propulsion systems
- Non-contact angular vibration velocity and angular vibration displacement measurements; structural analysis on rotating components
- Relative torsional vibration measurements
- Run-up, coast-down measurements; order analysis
- Dynamic torque-loading influence measurements
- Shaft speed measurements

FEATURES:

- Angular vibration velocity: 0.3 to 7000°/s (RMS)
- Angular vibration displacement: 0.01 to 12” (RMS)
- Speed: 30 to 7200RPM (higher with lower resolution)
- Measurements independent of target cross-section
- Signal-to-noise enhancement using random sweeps
- Remote measurements up to 0.5m
- Simple and quick to use
- Compact, lightweight, and portable
- Hand-held operation
- Battery powered

**The Torsional Vibration Meter Type 2523 was designed for making torsional vibration measurements where it is not feasible to mount a transducer onto a rotating object. Brüel & Kjær developed the Type 2523 based on a design by the Institute of Sound and Vibration Research, University of Southampton. You need not be concerned with the state-of-the-art laser technology used to make a measurement: the Type 2523 is an easy to use, highly accurate, reliable vibration measuring system.**

### Introduction

The Torsional Vibration Meter Type 2523 consists of a meter and a dual-beam laser transducer. The Type 2523 determines the instantaneous changes in angular velocity, and, by integration, in angular displacement, of a rotating component from the frequency difference of the retroreflectecl, Doppler-shifted beams.

The Type 2523 measures torsional vibrations *without* contacting the rotating surface. The ability to measure torsional vibrations easily and quickly can greatly simplify mechanical design and analysis. The Type 2523 is ideal in industries such as the automotive industry, where even small speed variations can lead to poor machine performance, premature failure, and human discomfort.

## How it works

A schematic of the electronic and optical components in the Type 2523 is shown in Fig. 1. The heart of the system is a low power (<1.5 mW), Ga-Al-As laser. The laser beam is split into two equal-intensity parallel beams separated by a distance, d (where $d = \mathbf{R_A} \cos \alpha_A + \mathbf{R_B} \cos \alpha_B$). The beams strike the shaft surface at points A and B, where the velocity is $\mathbf{V_A}$ and $\mathbf{V_B}$, respectively. Each beam sees only the velocity in the x-direction:

$$v_A = -\mathbf{V_A} \cos \alpha_A - \mathbf{V_x} = -\omega \mathbf{R_A} \cos \alpha_A - \mathbf{V_x}$$

$$v_B = \mathbf{V_B} \cos \alpha_B - \mathbf{V_x} = \omega \mathbf{R_B} \cos \alpha_B - \mathbf{V_x}$$

and is thus frequency-shifted:

$$f_A = \frac{2 v_A}{\lambda} \text{ and } f_B = \frac{2 v_B}{\lambda}$$

The returning beams then heterodyne, giving an output current modulated at the beat frequency, fn, that is, the difference between the frequencies of the Doppler-shifted beams:

$$f_D = f_B - f_A = \frac{2}{\lambda}(v_B - v_A) = \frac{2 \omega d}{\lambda}$$

Thus, the beat frequency is directly proportional to the shaft speed (w) and is independent of any solid body motion $(\mathbf{V_x} + \mathbf{V},)$ of the shaft.

If the plane of the laser beams is not perpendicular to the shaft axis, then $f_D$ is also a function of $\cos\theta$, where $\theta$ is the angle between the plane of the laser beams and the plane perpendicular to the axis of shaft rotation.

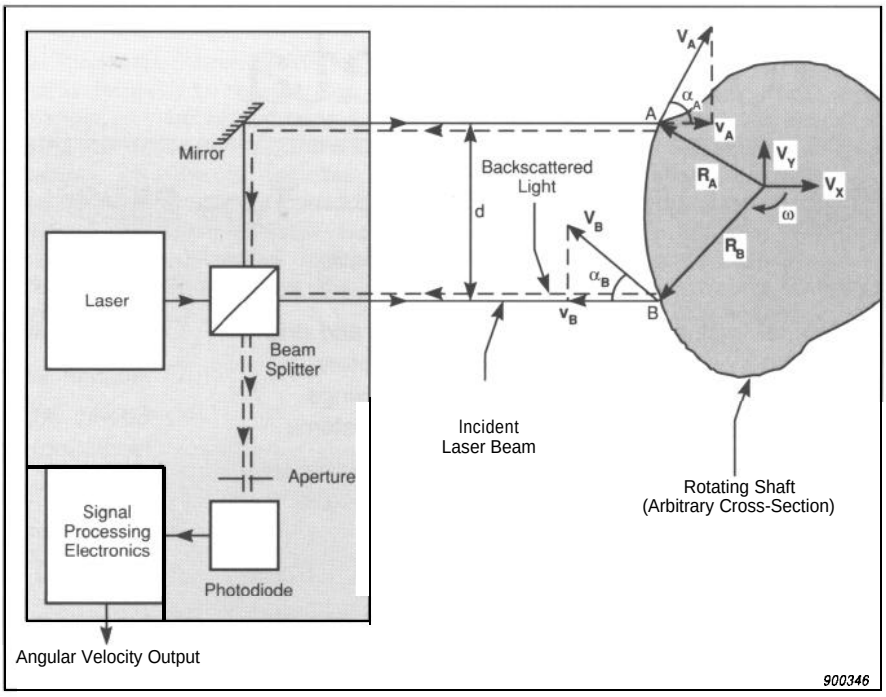


Fig. ***1. A schematic of the arrangement of the electronic and optical components within the Type*** 2523

## How to use the Type 2523

The Type 2523 requires no special alignment, calibration, or set-up procedures. All that is needed is a strip of retroreflective tape (QA0214, supplied) around the target. With the laser transducer mounted on its tripod, or held in the hand, point the beams at the tape and read the meter. Or send the output to a frequency analyzer together with a tacho signal and perform order analysis. See Fig. 2 for a typical set-up.

The optimum measuring distance from the laser transducer to the target is 5 to 50cm. The maximum recommended cable length from the transducer to the meter is 10m.

You may direct the light beams in a range of angles to either the side or the end of the target surface.

Four angular-velocity amplitude ranges and three angular-displacement amplitude ranges are provided

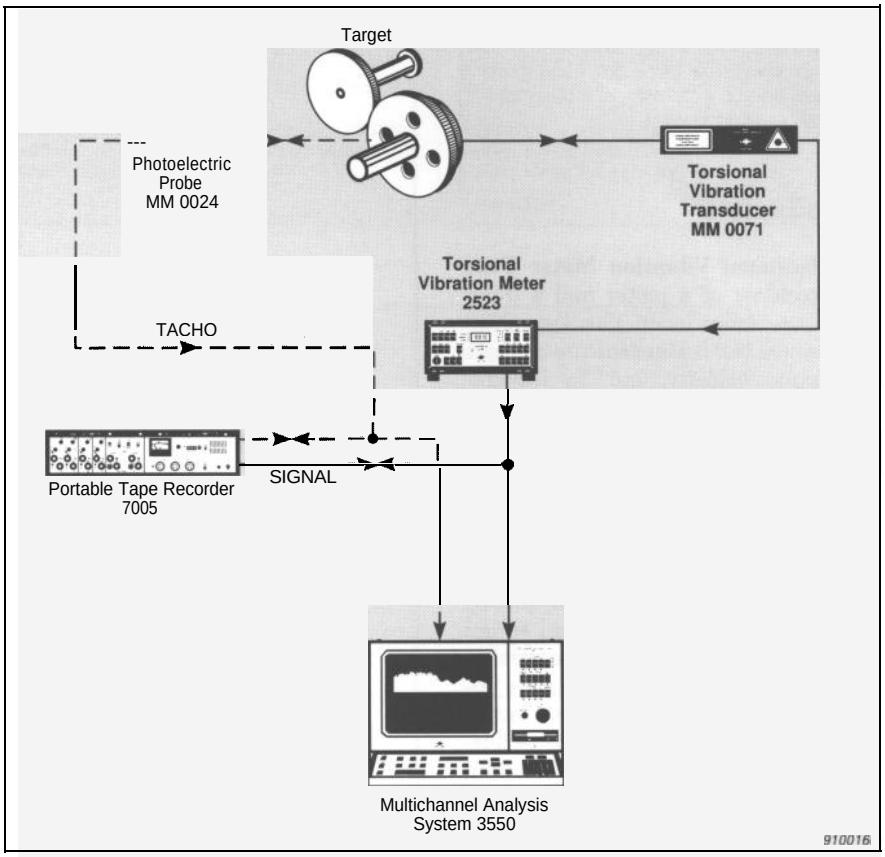


***Fig. 2. A typical measurement set-up for use with the 2523***

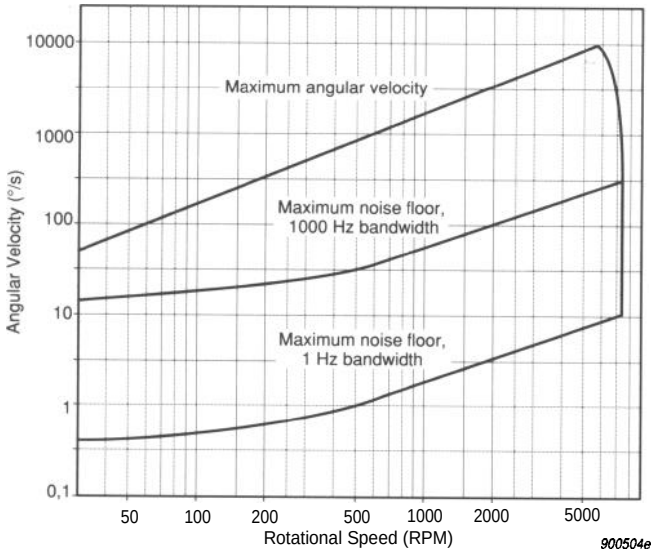


*Fig. 3a. Angular vibration velocity measurement range as a function of rotational speed*

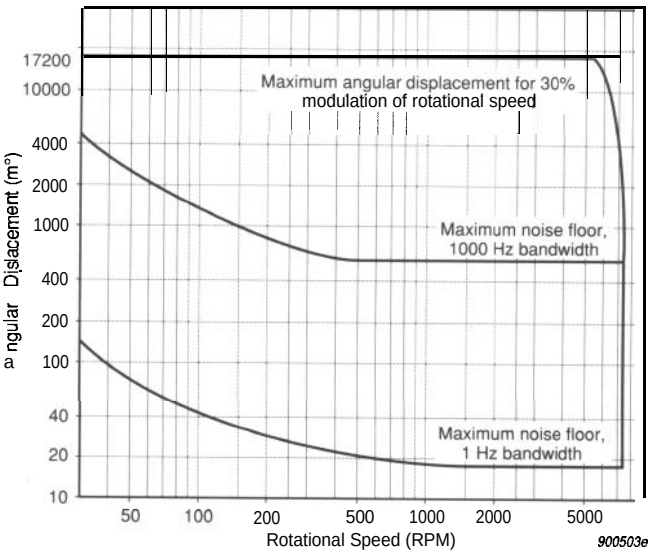


*Fig. 3b. Angular vibration displacement measurement range as a function of rotational speed*

so that the signal-to-noise ratio can be optimized for each measurement. The meter displays either the RMS value averaged over 1 or 10 seconds or the peak value.

## Fully portable

The Torsional Vibration Meter is powered by Battery Box ZG0146 containing six 1.5 V (IEC LR 20, "D" size) alkaline batteries (QB 0004) and comes complete with a sturdy carrying case containing all accessories.

The Type 2523 can also be powered by NiCd batteries or by an internal (ZGO199) or external power supply.

## Safety

The laser conforms to Laser Class 3B of IEC825 (1990) and ANSIZ136.1 (1986). Lasers in this class may not exceed 500mW and intrabeam viewing is always hazardous.

Each of the light beams is of low power (~0.7 mW), but is invisible to the human eye. Therefore, care must be taken not to stare directly into the light source, although it is not considered dangerous to accidentally catch the beam momentarily in the eye.

To minimize accidental exposure to the laser beams, a number of safety features are included in the laser design: the system is key-actuated from the meter; the laser can only be turned on from the transducer; the laser will automatically shut off if the target is not found within 20 to 30 seconds; and the transducer has a shutter to cover the beam window when measurements are not being made.

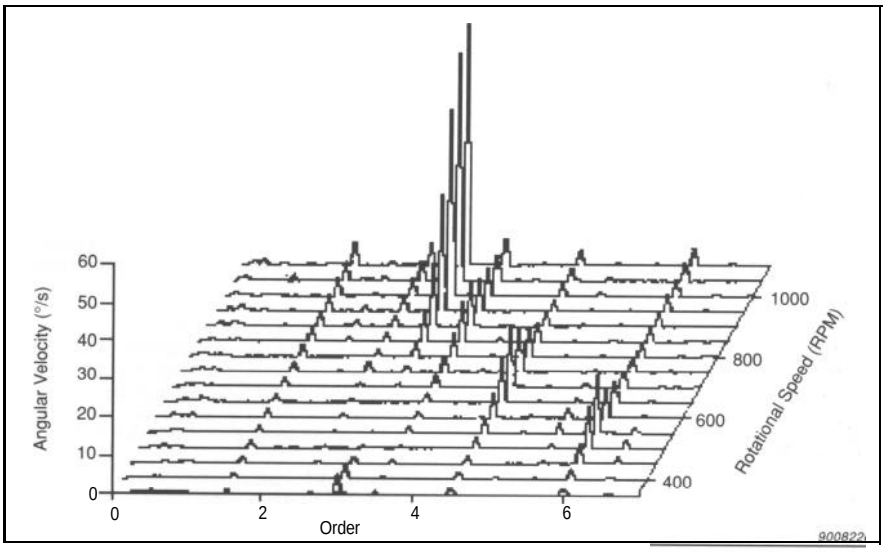


*Fig. 4a. Typical order analysis 3D plot from a run-up measurement*

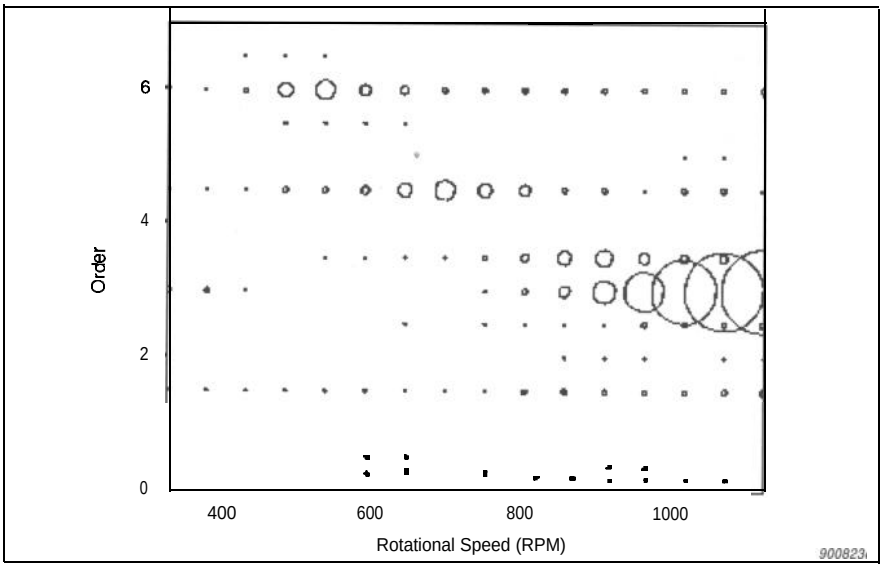


*Fig. 4b. Typical Campbell plot from the same run-up measurement*

## Measurement ranges

The Type 2523 is a torsional vibration measurement device. When used with a narrow-band analyzer, it can measure angular vibration velocities and corresponding angular vibration displacements, from 0.3 to 7000°/s (10000°/s peak) at frequencies from 0.3 to 1000Hz. An external filter, such as Tracking Filter Type 1623, can also be used within the 0.3 to 1000Hz range.

## Application areas

The Torsional Vibration Meter Type 2523 is designed to simplify the measurement of torsional vibrations. The fitting and calibration of conventional torsional transducers requires substantial machinery downtime. Attachment of the retroreflective tape is quick, thus minimizing machinery downtime and simplifying the measurement process.

Some typical applications are measurements on: shafts, crankshafts, propeller blades, geared systems, marine propulsion systems, and pump drives. Run-up, coast-down measurements are easy to perform and a variety of plots, including Campbell plots, can be generated using a computer PC and Brüel & Kjær 3D Plot Software WT9321 (see Fig. 4). Such measurements are often required in the automobile, aerospace, petrochemical, marine, and power industries.

# Specifications Type 2523*

**FUNCTIONS:**
Angular Vibration Velocity: 0.3 to 10000°/s (peak) for a bandwidth of 1 Hz
Angular Vibration Displacement: 0.01 to 17.2' (peak) for a bandwidth of 1 Hz
Rotational Speed: 30 to 7200RPM

**MEASUREMENT RANGES:**
Angular Vibration Velocity: 300 to 7000°/s (RMS values) 30 to 1000°/s 3 to 100°/s 0.3 to 10°/s
Angular Vibration Displacement: 0.3 to 12° (RMS values) 0.03 to 1° 0.01 to 0.1"

**FREQUENCY RANGE:**
0.3 to 1000 Hz

**LOW-PASS FILTER:**
2nd order Butterworth; -1.5dB upper frequency limit of 10, 30, 100, 300, or 1000Hz and an attenuation slope of 40dB/decade

**HIGH-PASS FILTER:**
2nd order Butterworth; -1.5 dB lower frequency limit of 0.3, 1, 3, 10, or 30 Hz and an attenuation slope of 40dB/decade

**DISPLAY:**
Display: Four digit LCD
Units: deg/s, mdeg, RPM
Noise Smearing On: Pseudo-random sweeps (to improve signal-to-noise ratio)

Averaging Time: 1 or 10s (applicable only to display and DC Output. not to AC and Rotational Speed Output)

**SIGNAL INPUT:**
Torsional Vibration Transducer: ll-pln socket
Tacho Probe: Single-ended BNT socket
External Filter Output Socket: 2V RMS, sine, 20 kΩ input impedance

**SIGNAL OUTPUT:**
AC: Full scale 3.16V RMS. sine, 1 kΩ Impedance (signal may be changed by 180°)
DC, lin: Full scale 3.16V., <100 Ω impedance
Accuracy: ±1% of full scale (±2% for speeds less than 100 RPM)
External Filter Input Socket: 2V RMS, sine, output impedance <100 Ω
Rotational Speed: 1 V/l 000 RPM
Trigger Pulse: Single-ended BNC socket
External Sampling: 64 or 128 pulses/rev (maximum 6000 RPM)

**POWER REQUIREMENTS:**
260148: 6 alkaline (QBOOO4) or 6 NiCd (QB 0008) batteries providing 6 or 3 hours of continuous operation, respectively
ZG 0199: Internally or externally
External Source: 6-15 V DC (0.5 A nominal, 2A peak)
External Charger: 12-14 V DC (0.4A Internal 'limit) If ZG0146 is used with NICd batteries
Signal Ground: Instrument case

**TORSIONAL VIBRATION TRANSDUCER:**
Laser: Ga-Al-As diode producing 780 nm light (Class 3B Laser)
Output Power: 2 x ~0.7 mW (total <1.5mW)
Distance Between Beams: 10mm
Operating Distance: 5 to 50cm
Laser Spot Diameter: Less than 1 mm
Dimensions: Height: 60mm Width: 35 mm Length: 290 mm
Weight: 0.8 kg

**RETROREFLECTIVE TAPE:**
Width: 20 mm
Thickness: 0.28mm
Length: 22.8 m
Weight: 17 mg/cm²

**ENVIRONMENTAL:**
Temperature: -10 to 55°C
Humidity: 90% RH (non-condensing at 40°C)
Shock: Type 2523: 25g; MM0071: 100g

**DIMENSIONS:**

| | |
|---|---|
| Meter: | Height: 136 mm |
| | Width: 251 mm |
| | Depth: 300 mm |
| Laser: | Height: 400 mm |
| (in carrying case) | Width: 480mm |
| | Depth: 120 mm |

**WEIGHT:**
Meter: 5.5 kg (with ZG0146 Inserted)
Laser: 5.4kg (in carrying case)

• Patented

# Ordering Information

| | |
|---|---|
| Type 2523: | Torsional Vibration Meter |
| Includes following Accessories: | |
| MM 0071: | Torsional Vibration Transducer |
| QA 0182: | Key |
| KE 0290: | Carrying Case |
| DH 0541: | Shoulder Strap |
| UA 0803: | Tripod |
| UA 0800: | Rotating Head for Tripod |
| ZG0146: | Battery Box |
| 6 x QB 0004: | Alkaline Batteries (1.5V; IEC LR 20, "D" Size) |
| AO 0337: | Connecting Cable (3m) |
| QAO214: | Roll of Retroreflective Tape |
| QA 0206: | Infrared Indicator |
| JPO710: | DIN Plug |
| JP 4742: | Shorting Plug |
| VF 0007: | Fuse (1.6A) |
| VF 0023: | Fuse (0.5 A) |
| | Instruction Manual |

### Optional Accessories

| | |
|---|---|
| ORDER TRACKING: | |
| Type 5050: | Order Tracking Multiplier |
| Type 1623: | Tracking Filter |
| Type 1621: | Tunable Band Pass Filter |
| MM 0012: | Photoelectric Probe |
| MM 0024: | Photoelectric Probe |
| WT 9321: | 3D Plot Software for IBM PCs |
| RECORDING: | |
| Type 7005: | Portable Tape Recorder |
| ZM 0053: | FM Unit |
| ZE 0299: | Direct Unit |
| Type 2317: | Portable Level Recorder |
| GENERAL: | |
| GA 0214: | Retroreflective Tape |
| ZG 0146: | Battery Box |
| GB 0004: | Alkaline Batteries (1 .5 V; IEC LR 20, "D" Size) |
| QB 0008: | NiCd Batteries (1.25V; IEC R 20, 'D" Size) |
| ZG 0199: | Power Supply (100 to 240VAC) |
| AO 0337: | Connecting Cable (3 m) |


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